Field Sampling Plan for the 2005 Sediment Quality Evaluation of Delaware River Estuary

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Prepared for:

Aquatic Technical Work Group for *ATHOS I* Spill

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1.0 Introduction

1.1 Background

On Friday, November 26, 2004 (approximately 2100 hrs), the *M/T ATHOS I*, a 230 m oil tanker, was reported to be leaking oil into the Delaware River while executing a berthing maneuver en route to its terminal at the CITGO asphalt refinery in Paulsboro, NJ. The spill occurred in the vicinity of the Mantua Creek, which is located directly across the river from the Philadelphia International Airport. By January 14, 2005, the Coast Guard estimated that approximately 1,030,850 L of Venezuelan crude oil had been spilled into the Delaware River from the *M/T ATHOS I*. Despite aggressive response efforts by the U.S. Coast Guard, state response agencies, and the Responsible Party (RP), oil was reported along approximately 91 to 186 km of shoreline from the Tacony-Palmyra Bridge to south of the Smyrna River in Delaware (Polaris Applied Sciences, Inc. 2005).

Of the total quantity of oil spilled into the Delaware River, roughly 503,506 L of oil and oily liquid and 13,428 tones of oily solids were recovered/collected from the river (Polaris Applied Sciences, Inc. 2005). Accordingly, it can be estimated that at least one-half of the oil (i.e., 515,425 L) that was released into the river was not recovered and, hence, remained in the Delaware River system. As the ultimate fate of this oil is not known and such quantities of oil have the potential to adversely affect natural resources in the Delaware River and Delaware Bay, the Natural Resources Trustees are conducting a preliminary assessment of sediment quality conditions to determine if the oil released from the *M/T ATHOS I* could have contaminated sediments to such an extent that injuries to sediment-dwelling organisms could have occurred and/or could be occurring within the Assessment Area.

This document, termed the Field Sampling Plan (FSP), describes the standard operating procedures (SOPs) that will be used to collect and analyze 140 whole-sediment samples from the Delaware River to evaluate contamination by PAHs and perform VSORS monitoring. A general description of the sampling plan and supporting rationale is provided in the 25 August 2005 memorandum "Proposed Aquatic Sediment Sampling and Analysis Design." In addition, this FSP documents the procedures that will be used to collect and archive 140 whole-sediment samples from the Delaware River for possible future analysis of sediment chemistry and sediment toxicity.

1.2 Sampling and Analysis Plan for the Delaware River Estuary

A sampling and analysis plan (SAP) consists of three primary elements, including a quality assurance project plan (QAPP), an FSP, and an associated health and safety plan (HSP). The QAPP describes the policy, organization, functional activities, and quality assurance and quality control protocols necessary to achieve project data quality objectives (DQOs) dictated by the intended use of the data. In contrast, the FSP provides guidance for all fieldwork by defining in detail the sampling and data gathering methods to be used on the project.

For the 2005 field sampling program, the SAP consists of three separate, but mutually supportive, documents, including:

- Field Sampling Plan for the 2005 Sediment Quality Investigation of the Delaware River Estuary (this document);

- Quality Assurance Project Plan for the 2005 sediment quality investigation (Note: Procedures for UVF PAH analysis are provided in this document. Given the relatively small number of samples planned for confirmatory laboratory analysis under this program, existing quality assurance and quality control protocols used for Athos-related sediment analyses will be applied to this effort. Development of a formal QAPP document will be considered if the investigation proceeds beyond this preliminary sampling effort); and,

- Health and Safety Plan (Note: This document will be prepared separately).

This document describes the FSP that will be conducted in September, 2005 to assess sediment quality conditions in the Delaware River Estuary. More specifically, this FSP includes:

- Introduction (Section 1);
- Sampling objectives (Section 2);
- Sampling program design (Section 3);
- Sampling locations and frequency (Section 4);
- Sampling timing (Section 5);
- Sample designation (Section 6);
- Sampling equipment and procedures (Section 7);
- Sample handling and analysis (Section 8)
- Chemicals of potential concern (Section 9);
- Roles and responsibilities of the sampling team (Section 10);
- Quality assurance (Section 11);
- Examples of forms and instructions for filling out that paperwork (Section 12);
- VSORS procedures (Section 13); and
- References cited (Section 14).

2.0 Sampling Objectives

The 2005 field sampling program is intended to provide the information needed to determine if discharges of oil from the *M/T ATHOS I* spill are likely to have degraded sediment quality conditions in the Delaware River Estuary. More specifically, the objectives of the sampling program are to:

1) Obtain real-time data on the concentrations of PAHs in 140 whole-sediment samples collected from the vicinity of the *M/T ATHOS I* oil spill [i.e., using indicator-chemistry analyses involving field extraction of whole-sediment samples and associated quantification of PAHs using ultraviolet fluorescence (UVF) methods];

2) Confirm the results of UVF-based chemical analyses of whole-sediment samples through analysis of a sub-set of the collected samples for PAHs using gas chromatography/mass spectrometry-selective ion monitoring (GS/MS-SIM) in the laboratory;

3) Collect and archive whole-sediment samples from each sampling station for possible future analysis of selected chemicals of potential concern (COPCs) and toxicity to sediment-dwelling organisms (e.g., amphipods, *Ampelisca abdita* and/or *Leptocheirus plumulosus*); and

4) Collect VSORS data in areas upstream and downstream of the sediment sampling zone to generate information on the presence/absence of submerged tarmats or other agglomerations of oil/oiled sediments that could be a source of ongoing, physical impacts to river sediment habitat.

3.0 Sampling Program Design

The sampling program design is described in the 25 August 2005 memorandum "Proposed Aquatic Sediment Sampling and Analysis Design."

4.0 Sampling Locations and Frequency

The sampling locations that were selected for inclusion in the 2005 field sampling program for the Delaware River Estuary are shown in Figures 8-10, with coordinates specified in Table 1.

A step-wise approach was used to select sampling stations for the 2005 field sampling program. First, a base map of the study area was prepared using ESRI ArcMap software from the coverages provided by Sommerfield and Madsen (2003). Subsequently, depositional areas within the study area were identified using the sedimentological information from Sommerfield and Madsen (2003). Next, polygons (i.e., primary strata) were drawn that covered the depositional habitats identified above. Within each of the primary strata, a total of between 15 and 33 substrata were identified by creating grids of appropriate size (i.e., the area of each primary stratum was divided evenly by the number of substrata it contained). The number of substrata identified depended on the size of the primary strata and its vicinity to the spill site. Subsequently, one sampling station was randomly selected from within each substratum using the FIELDS tools. Because each sampling station was randomly selected for each substratum, the conditions observed at that station will be considered to represent conditions throughout the entire substratum.

For the other targeted sampling areas listed above (i.e. the navigational channel, and the non-depositional and non-channel areas), sample sites were either evenly spaced or located within suspected zones of contamination.

Whole-sediment samples will be collected at each of the sampling stations identified in Table 1, unless:

- It is not possible to access the predetermined site;
- Inadequate or unusable sediment (i.e., rocks or gravel) is available at the site; or,
- Unsafe conditions are apparent at the site.

If it is not possible to sample surficial sediments at the predetermined site, then the sediment sample may be collected at an alternate site located with 25 m of the original station. The coordinates of the alternate sampling station should be recorded once an acceptable sample has been collected. If an acceptable sample cannot be collected at the adjusted sampling location, the station should be abandoned and no sample will be collected at the station.

The target analytes for the top-layer sediment samples and for the surficial sediment samples are shown in Table 2.

Each sampling station will be sampled using sediment grab techniques once during the September, 2005 sampling program. At each station, a grab sediment sample will be collected and the upper 2 cm of material from the grab homogenized to facilitate sub-sampling of the sediment for on-site and/or laboratory analysis of PAHs. In addition, the upper 10 cm of material from the grab will be homogenized to facilitate sub-sampling of the sediment for possible future evaluation of COPC concentrations and sediment toxicity.

The integrity of the sampling program is, in part, dependant on collection of sediment samples from the prescribed sampling stations. Accordingly, the coordinates identified in Table 1 should be entered into a wide area augmentation system (WAAS) capable GPS and verified by an independent observer. Subsequently, the coordinates for each station should be downloaded from the GPS unit and plotted to ensure that sampling locations correspond to those identified in this FSP. The same GPS unit should then be used to navigate to each sampling location.

5.0 Sampling Timing

The sediment sampling to support the Delaware River sediment quality assessment will be conducted on September, 2005. During this period, sediment samples will be collected at a total of 140 sampling stations in the Delaware River Estuary. Because the sampling program will be conducted over a relatively short period of time (i.e., 1-2 weeks), there is no need to randomize the schedule for collecting the sediment samples.

6.0 Sample Designation

The sample numbering system that will be used to designate sediment samples that are collected to support the assessment of sediment quality conditions in the Delaware River Estuary is presented in Table 1.

7.0 Sampling Equipment and Procedures

7.1 Information to be Collected at Sampling Stations

The following basic information will be collected and recorded at each sampling station:

- Sample station name and number;
- Sampling date and time;
- Type of vessel used (including length and power);
- Latitude and longitude or UTM coordinates (i.e., of actual location of sampling, including datum, instrumentation used, and any problems encountered in locating the station);
- Weather conditions, including precipitation, wind speed and direction, sea state (i.e., wave height), etc.;
- Type of sampler used;
- Names of sampling personnel; and,
- Water depth.

7.2 Equipment and Sampling Procedures

Table 3 lists the equipment that will be used to collect sediment samples for the 2005 Delaware River Estuary field sampling program. Sediment samples will be collected using a Smith-McIntyre grab sampler (31 cm x 31 cm; volume of 10-20 L) or a Van Veen grab sampler (35 cm x 70 cm; volume of 18 L), targeting the top 10 cm of sediment). Sediment samples for indicator chemistry analysis and confirmational chemical analysis will target the top 2 cm of sediment, while the samples for archiving (for possible full chemical and toxicological analysis) will target the top 10 cm of sediment.

At each sampling station, the sediment sampler will first be rinsed with site water, then with acetone, and finally with site water to prevent cross-contamination among samples. Then, the sampler will be deployed, gently extracted from the sediment, and slowly and carefully raised through the water column to minimize sample disruption during retrieval. Once the sampler has been retrieved from the water and secured on the deck of the boat (in a stainless steel tray), the screen doors will be opened and any excess water that is retained on the sediment surface will be siphoned off (using a thoroughly cleaned siphon or turkey baster). The following information should be recorded following retrieval of the sampler (also see Addendum 1A):

- Unusual events that occurred during sampling (i.e., sampler did not close completely, etc.);
- Presence or absence of overlying water in sampler;

- Sample depth (i.e., sediment surface to bottom of sampler);
- Description of sediment type (i.e., silt, sand, clay, mud, shells, detritus);
- Description of sample color (i.e., black, brown, etc.);
- Description of sample odor, if readily apparent (i.e., sulfur, oily, sewage, none; Note: do not intentionally smell sample to evaluate odor);
- Description of surface biology (i.e., molluscs, crustacea, tube worms present, etc.); and,
- Sample processing procedure used (i.e., number of grabs taken at site, volume of sample taken from each grab, total volume collected, homogenization methods, sub-sampling methods, type of containers used; Table 4).

Any grab samples that are not intact following retrieval (i.e., low volume, partially washed out, incomplete closure of sampler, etc.) should be discarded. Each sample that is retained should be photographed using a digital camera, with a card indicating the sample identification number. Following visual examination of the sample, two types of samples will be obtained from the sampler, including a top-layer sediment sample (i.e., 0 - 2 cm) and a surficial sediment sample (i.e., 0 - 10 cm).

The top-layer sediment sample will be obtained by removing approximately 450 mL of sediment from one side of the sampler, taking care to remove only the top 2 cm of material. This material will be transferred into a stainless steel sample collection container (i.e., 500 mL) using a stainless steel spoon. This material will then be homogenized and used to fill 3 - 125 mL pre-washed amber glass sample jars. One sub-sample will be used for on-site analysis using UVF to estimate PAH concentrations. Another sample will be transported to a storage facility and possibly analyzed later (using GS-MS/SIM) to confirm the results of the indicator chemistry results (i.e., roughly 10% of these samples will be used to validate the on-site UVF results). The third sample will be used for analysis of total organic carbon (TOC). The samples that are selected for confirmatory chemical analysis will be identified following review and evaluation of the UVF data.

The surficial sediment sample will be obtained by removing approximately the top 10 cm of the sediment from the other side of the sampler and transferring it to a large, stainless steel sample collection container (i.e., 5000 mL) using a stainless steel spoon. This material will then be homogenized and used to fill a 4000 mL pre-washed, high-density polyethylene sample jar. This sample will then be archived for possible future analysis of whole-sediment chemistry and whole-sediment toxicity. Following sub-sampling of the material in the grab sampler, the remainder of the sample will be discarded.

The grab sampler will be decontaminated following collecting and processing of the sample collected at each sampling station. First, a stainless steel or Teflon spatula will be used to scrape the remaining sediment from the sampler into the waste sediment bucket. Next, the sampler will be scrubbed with a long bristle scrub brush and sprayed with a high pressure hose to remove any remaining sediment. Then, the dredge will be squirted with alconox solution,

scrubbed, and rinsed. Finally, the dredge will be rinsed with acetone to complete the decontamination process. This decontamination process should also be applied to the stainless steel pan into which the dredge is placed when brought onboard the vessel. The waste sediment that has accumulated in the waste sediment bucket should be returned to the water after all sampling has been completed at the sampling station (i.e., the excess sediment should be returned to the water before leaving the sampling station). All of the acetone that is used in the decontamination process will be collected and disposed of in an appropriate manner.

7.3 Other Precautions to Avoid Sample Contamination

Generation of reliable data on sediment quality conditions is a primary objective of the sampling program. As such, all reasonable efforts should be made to minimize the potential for sample contamination during the sample collection, handling, and processing process. At a minimum, steps that should be taken to avoid sample contamination include:

- Washing all of the surfaces of the sampling vessel following refueling;
- Approaching the sampling station from the downwind direction;
- Stabilizing the boat by anchoring and shutting off the motor upon arrival at the sampling station;
- Waiting for a few minutes before initiating sampling activities to allow the air to clear;
- Ensuring that sediment samples do not come in contact with any item that has not undergone the approved decontamination process;
- Ensuring that any utensils that are used in the sediment sampling process do not come in contact with any item that has not undergone the approved decontamination process (the sampler, corer, and other sampling utensils should be placed in the stainless steel pan during transit between sampling stations);
- Fully decontaminating all sampling equipment after sampling has been completed at a sampling station; and,
- Prohibiting any activity on the sampling vessel that could result in sample contamination (e.g., refueling with sediment samples or sample equipment on board, smoking, consumption of food or drinks during the sampling process; Note: there will be a cooler on deck for food and drinks that are to be consumed at appropriate times).

7.4 Precautions to Avoid Exposure to Contaminated Sediments

It is anticipated that contaminated sediment will be routinely encountered during sampling throughout much of the study area. As such, the sampling crew should take precautions to minimize exposure to potentially toxic and/or bioaccumulative substances. At a minimum, steps that should be taken include:

- Handling sampling equipment and sediment samples carefully;

- Avoiding direct dermal contact with sediments; and,

- Wearing protective equipment, such as gloves, safety glasses, long-sleeved shirts, long pants, rubber boots, and/or rain gear.

More detailed guidance on avoiding hazards during sampling and minimizing the potential for personal injury is provided in the project Health and Safety Plan.

8.0 Sample Handling and Preparation

Procedures for handling and preparing samples for chemical analysis and/or toxicity testing should follow the procedures described in ASTM (2004a; also see Table 4). Briefly, following collection, sediment samples will be processed on board the sampling vessel. Processing of grab samples will consist of sample homogenization using a stainless steel spoon. Care will be taken to minimize the entrainment of air into the sample during homogenization of sediment samples. Samples will be considered to be homogenized when the entire sediment sample has a uniform texture, color, and consistency.

For the top-layer sediment samples, sub-samples will be obtained for chemical characterization following homogenization. It is anticipated that the following sub-sample volumes will be needed to support the various chemical analyses currently planned for the samples:

1. Whole-Sediment (WS) Chemistry

- UVF analysis for PAHs	125 mL
- GS/MS-SIM for PAHs	125 mL
- TOC	125 mL
	375 mL (WS)

For surficial sediment samples, a single sub-sample will be obtained for archiving and possible future chemical and toxicological characterization. If the Trustees choose to undertake such efforts, selected samples will be homogenized in the laboratory and sub-sampled to support a series of physical and chemical analyses and whole-sediment toxicity testing. It is anticipated that the following sub-sample volumes will be needed to support potential chemical analyses and toxicity tests that might be undertaken after evaluation of the UVF and 16 confirmatory lab results currently planned:

2. Whole-Sediment Chemistry

- % Moisture	125 mL
- TOC	125 mL
- Grain size	500 mL
- Total metals	125 mL
- SEM/AVS	125 mL
- PAHs (34 analytes)	125 mL
- SVOCs	125 mL
- PCBs/Pesticides	250 mL
	1.5 L (WS)

3. Whole-Sediment Toxicity

- 10-d *Ampelisca abdita* toxicity test	800 mL
- 28-d *Leptocheirus plumulosus* toxicity test	800 mL
- Pore-water characteristics	400 mL
	2.0 L (WS)

Based on this summary, it is estimated that roughly 3.5 L of whole sediment could be needed to support potential future characterization of whole-sediment chemistry and toxicity, in addition to the 375 mL of whole sediment needed to characterize the top-layer sediment samples under the current program. A total of 4.0 L of whole sediment will be collected and archived for each sample.

Following sample homogenization, sub-samples should be transferred to labeled sample containers using stainless steel spoons and high-density polyethylene funnels. All sample containers should be filled to the top to minimize exposure of the sediment to air. After applying the lid to the sample container, the lid should be further secured using electrical tape (i.e., to minimize the potential for sample spillage during shipping). Following sample preparation, the sub-samples should be stored at 4^{o} C until packed for transport/shipping. All sediment samples that are not analyzed on site should be carefully packed with bubble wrap and blue ice, and shipped to the appropriate laboratory for storage in 48 L plastic coolers, along with the appropriate chain of custody forms. An inventory must be maintained of all samples that are shipped each day to facilitate confirmation of receipt the following business day. Archived samples should be stored in a walk-in cooler in the dark at 4^{0}C.

9.0 Chemicals of Potential Concern

Donlan *et al.* (2005) evaluated the potential toxicity of oil originating from the *M/T ATHOS I* oil spill, as well as potential toxicity of the constituents of that oil. Based on the results of that evaluation, PAHs were identified as the primary chemicals of potential concern (COPCs) relative to the oil spill. For this reason, PAHs will represent the principal target analytes in this investigation of sediment quality conditions in the Delaware River Estuary. However, the results of previous studies conducted within the study area (e.g., Hartwell *et al.* 2001) show that sediments within the Assessment Area are contaminated by metals, PAHs, PCBs, and other substances. Therefore, future analyses of archived sediment samples collected in the 2005 field sampling program might not be limited to PAHs. The list of priority analytes for whole sediments and associated data quality objectives (DQOs) for the chemical analyses are presented in Table 5. DQOs for additional analytes will be developed later. The standard operating procedures for analysis of PAHs (on-site UVF and in the laboratory) and TOC are included in Appendix 2.

10.0 Roles and Responsibilities of Sampling Team

Samples to support the sediment quality investigation will be systematically-collected within the sampling area. The sampling team will include three individuals who will be responsible for operation of the sampling vessel, collecting and preparing whole-sediment

samples, conducting on-site analyses of sediment samples, and preparing and shipping samples for possible future analysis. All members of the sampling crew will be required to wear personal flotation devices at all times while on the water. A fourth team member will comprise the sampling analysis and shipment crew, with assistance from the sampling collection crew as needed.

The sample collection crew will be responsible for assuring that all necessary sampling equipment and associated supplies are loaded onto the sampling vessel(s) each day, verifying the locations of the stations that are sampled (using WAAS-capable GPS), collecting sufficient volumes of sediments to support analyses of sediment chemistry and sediment toxicity, preparing and labeling sediment samples, and decontaminating the sediment samplers between deployments at a site and following the completion of sampling activities at each station. It is anticipated that one person will deploy and retrieve the sediment sampler, assist during sample preparation, and decontaminate the sampler prior to redeployment. A second person will measure the depth of penetration, retrieve the sediment from the dredge for homogenization and sub-sampling, and prepare and label the samples for UVF analysis and storage. The third person will operate the boat and collect field notes.

The sample analysis and shipping person will be stationed at the field laboratory (or on-board the sampling vessel) and will be responsible for receiving sediment samples from the sample collection crew, for assuring that all sub-samples are appropriately labeled, conducting on-site chemical analyses, preparing the sub-samples for shipment, and for shipping the sub-samples as directed.

Sediment samples should be cooled to 4^{o}C prior to shipment and shipped in a manner that assures that this temperature is maintained. Any sub-samples that are lost or damaged during transport must be identified by sampling station and recorded. Sub-samples may be shipped on Monday, Tuesday, Wednesday, Thursday, and Sunday only (to avoid weekend delivery to laboratories). Any sub-samples that are not shipped on the date of collection must be held on site at 4^{o}C and shipped on the next appropriate shipping day (i.e., on ice in coolers). Unused portions of sediment samples should be disposed of at the station that the samples were collected.

Sample collection and disposition will be clearly documented. Pre-printed labels with sample numbers will be used for containers. Labels contain the sample numbers listed in Table 2 and the sub-sample number and volume. At each sampling station, the data collection form will be filled out (see example in Addendum 1A). Samples will then be stored in coolers on ice. At the end of the collection effort, samples will be shipped to a laboratory or transferred to a long-term storage facility. Samples shipped to a laboratory will be packaged in a cooler with blue ice as described in Section 8.0 and a chain of custody (COC) manifest will be prepared (see example in Addendum 1B). A copy of the COC will be maintained with the sample records, and the initial disposition will be noted on the data collection form. The laboratory will also fax or mail a copy of the updated COC to the sender upon receipt and acceptance. Samples transferred to the long-term storage facility will be packaged in coolers. A chain of custody will be prepared for each cooler and enclosed inside it, with a copy maintained with the sample records. A sample list will be affixed to the exterior of each cooler to facilitate sorting and identifying samples in the storage facility. In the likely scenario that individual samples are selected from the storage facility for analysis, rather than entire coolers, a new COC will be initiated for each

set of samples when it is repackaged for shipment. The disposition and transfer to a new COC will be noted on the original COC, and the external sample lists will be updated as necessary.

11.0 Quality Assurance

Generation of good quality sediment chemistry and toxicity data is essential for supporting the 2005 sediment quality investigation of the Delaware River Estuary. To avoid problems associated with data reliability, it is necessary to implement adequate quality assurance measures in the sampling program. In this study, the quality of field collected data will be evaluated by conducting laboratory analysis of a sub-set (roughly 10%) of the field-collected samples using GC/MS-SIM methods, consistent with those used in the National Status and Trends Program (i.e., 13 parent + alkylated PAHs).

Given the relatively small number of samples initially planned for laboratory analysis under this program, existing quality assurance and quality control protocols used for Athos-related sediment analyses will be applied to this effort. Development of a formal QAPP document will be considered if the investigation proceeds beyond this preliminary sampling effort.

12.0 Examples of Forms for Sampling Program

Examples of forms that will be used in the sample program are presented in Appendix 1, including the data collection form (Addendum 1A) and chain of custody form (Addendum 1B).

13.0 VSORS

Figure 12 shows a picture of the Vessel-Submerged Oil Recovery System (VSORS) apparatus used during Athos spill response. Each VSORS consists of a pipe with attached chains and snare. The VSORS is towed behind a vessel on the bottom at slow speeds. It is pulled up regularly and inspected for oil. The VSORS used for this monitoring effort will be smaller than that shown in Figure 12, which allows us to use a smaller boat and is consistent with the monitoring rather than oil recovery focus of this effort.

We plan to undertake three days of VSORS monitoring, with transects originating at the downstream and upstream border of the sediment sampling area and continuing as far as time allows. The first few hours of the first VSORS day will be spent dragging it in "test" areas where we expect to find oil that should be picked up by VSORS (based on visual inspection of sediment grabs discussed above, recent reports of continued shoreline oiling/tarmats, and/or along the southern face of Tinicum Island where post-spill VSORS confirmed the presence of subtidal sediment oiling). Based on these results, we will make a decision about whether or not to continue with the VSORS monitoring effort.

If we go forward with VSORS, we plan to first sample a single longitudinal transect upstream of the sediment sampling zone where moderate shoreline oiling was observed. The transect is approximately 10km long, extending from the upstream end of the sediment sampling area to the upstream end of Petty Island (across from the confluence with Cooper River). The exact location of the transect will be left to the discretion of the VSORS field team.

We will then sample two longitudinal transects downstream of the sediment sampling zone in as long a stretch of river as we can cover, given currents and some experimentation with the VSORS to determine speeds that can be achieved while keeping the VSORS on the river bottom. One transect will be on the north/west side of the river, approximately equidistant between the middle of the river and the shore (but not in the navigation channel). The other transect will be on the south/east part of the river, also approximately equidistant between the middle of the river and the shore (but not in the navigation channel). The exact location of the transects will be left to the discretion of the VSORS field team. In locations where the shipping channel approaches the shore, both transects may be taken on the same side of the channel but will be spaced apart to improve river bottom coverage. In general, we propose two "downstream" transects because of the greater river width and the potential for spring floods or other hydrological events to have moved contaminated sediments downstream.

For all transects, the VSORS will be surveyed for oil coverage every mile or 30 minutes of transect time, whichever comes first (unless field conditions or results from initial VSORS efforts indicate that another frequency is warranted). A field observer will record the percent coverage using the following categories: no oil observed: <5% coverage; 6-10%; 11-25%; 26-50%; 51-75%; and 76-100%. A digital photograph will be taken of each observation were oil coverage is noted. In addition, latitude and longitude (or UTM coordinates) and water depth will be recorded when the VSORS is placed into or removed from the water and at regular intervals during transects. Boat speed also will be recorded at these intervals, and will be kept as constant as practicable in between oil coverage observations.

VSORS or individual snares will be replaced at the discretion of the field observer. The VSORS team will include two people; one responsible for making the VSORS observations and recording the additional information noted above, and the other responsible for operating the boat.

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